

A text mining analysis of preservice teachers' reflective discourses in online teaching: basis for a policy brief

Julius Ceazar G. Tolentino¹, John Paul P. Miranda²

¹College of Education, Pampanga State University, Pampanga, Philippines

²College of Computing Studies, Mexico Campus, Pampanga State University, Pampanga, Philippines

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ABSTRACT

This study examined the reflections of 142 preservice teachers who taught online during the COVID-19 pandemic. This study identified common themes, emotions, and patterns in their experiences using sentiment analysis and hierarchical clustering. The most frequently used words, such as “learn,” “experience,” and “time,” highlight themes of learning and action. Sentiment analysis shows that most of their reflections are positive, using words like “well,” “good,” and “great.” Hierarchical clustering revealed three main themes in their reflections: i) professional growth and development; ii) passion for teaching and connection; and iii) adaptability and resilience. These themes show the complex nature of their experiences. While focusing on personal and professional growth, a strong commitment to teaching, and adaptability in challenging situations was evidenced. The findings of this study will help create a policy brief addressing these themes. Recommendations include strategies for professional growth in online teaching, encouraging a love for teaching through online platforms, and improving teacher training programs to build adaptability and resilience. Policymakers and educators can use these insights to develop effective policies and practices that support preservice teachers in online teaching even during health crises or similar disruptions.

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Corresponding Author:

Julius Ceazar G. Tolentino

College of Education, Pampanga State University

Pampanga, Philippines

Email: jcgtolentino@pampangastateu.edu.ph

1. INTRODUCTION

The rapid shift to online teaching during the COVID-19 pandemic reshaped teacher education worldwide [1]. This transition accelerated the need for digital competency and adaptability among preservice teachers. Traditional teacher education emphasized in-person classroom management, hands-on pedagogical training, and direct student engagement. Remote instruction disrupted these conventional models and exposed persistent challenges related to digital infrastructure, pedagogical readiness, and institutional support [1]. In the ASEAN region, particularly in the Philippines, disparities in digital access and technological proficiency created significant obstacles for preservice teachers [2]–[4]. This makes an important point for the need to understand how future educators reflect on their experiences in digital classrooms for improving teacher preparation. Despite the growing emphasis on digital education, few studies have examined the reflective discourses of preservice teachers particularly in their teaching internship. This gap limits understanding of how they process and adapt to the challenges of online instruction.

Preservice teachers in the Philippines encountered multiple difficulties in transitioning to online teaching [5]. Many struggled with inconsistent internet connectivity, inadequate digital training in teacher

education programs, and limited institutional support for online instructional strategies [5], [6]. These barriers affected their ability to engage students effectively and adapt to remote learning environments. Some preservice teachers faced difficulties incorporating interactive teaching methods due to their unfamiliarity with digital tools. Others reported challenges in maintaining student participation and assessing learning outcomes in virtual settings [7]. The shift to online instruction intensified these issues, making digital pedagogy more complex to implement. Addressing these concerns requires a deeper understanding of how preservice teachers perceive and respond to these obstacles during their training. As such, reflective writing offers valuable insights into preservice teachers' experiences with online instruction. Unlike surveys or structured interviews, written reflections capture their thoughts, emotions, and strategies in their own words. These reflections may provide a nuanced perspective on their struggles, growth, and pedagogical adjustments. By analyzing these narratives, researchers can identify common themes, emotional responses, and patterns that might not be evident through conventional qualitative methods. Advancements in computational analysis like Sentiment analysis helps determine emotional responses to online teaching challenges [8], while hierarchical clustering reveals recurring themes in reflective discourses [9]. These analytical approaches allow for a systematic examination of preservice teachers' adaptation processes and the factors that shape their teaching experiences.

This study contributes to teacher education research by examining preservice teachers' reflective discourses on online instruction. It aims to provide an evidence-based understanding of their adaptation strategies, technological challenges, and instructional adjustments. This research highlights how preservice teachers navigate digital teaching environments and may develop resilience despite technological and pedagogical barriers. By applying text mining techniques to reflective writing, this study introduces an innovative approach to analyzing preservice teachers' learning experiences. The insights gained from this research can inform teacher education programs, improve digital training strategies, and support institutional policies that enhance online teaching preparation. As education systems continue to integrate digital learning, understanding how preservice teachers reflect on their experiences is crucial for shaping effective and sustainable teacher training models.

This study aims to investigate and analyze preservice teacher reflective document discourses about virtual teaching in an online learning environment during the COVID-19 crisis, utilizing sentiment analysis and hierarchical clustering techniques to gain insights into their emotional responses and identify patterns and themes in their experiences. Specifically, the study aims to do the following: i) to examine preservice teachers' reflective document discourses about teaching internship in an online learning environment during the covid-19 crisis; ii) to utilize sentiment analysis to assess the emotional responses of preservice teachers as reflected in these documents; and iii) to apply hierarchical clustering techniques to identify patterns and themes in preservice teachers' reflective documents.

2. LITERATURE REVIEW

2.1. Virtual teaching internships and student reflections

Understanding the reflections shared by preservice teachers engaged in virtual teaching internships during the COVID-19 pandemic holds significant importance for multiple reasons. For example, virtual internships have proven to be effective in fostering the technological pedagogical content knowledge (TPACK) of preservice teachers [10]. Additionally, as a result of the pandemic, preservice teachers have had to adapt to virtual teaching, making it crucial to comprehend their perceptions and experiences, which can in turn inform future teacher education and professional development initiatives [11]–[16]. Moreover, virtual internships and simulated teaching experiences can help alleviate professional anxiety among preservice teachers and equip them with the necessary skills for the actual teaching environment [10], [17], [18]. By comprehending the reflections of preservice teachers, valuable insights can be gained regarding the usability and viability of virtual teaching and learning platforms both during and post-pandemic [19]. Consequently, it is imperative to actively listen to and analyze the reflections of preservice teachers engaged in virtual teaching internships during the COVID-19 pandemic as a means to inform teacher education and professional development endeavors.

2.2. Text analysis applications in education

Text analysis as a research method in education serves various purposes, particularly when examining student reflections and feedback. For instance, techniques such as hierarchical clustering and emotion analysis have been employed (e.g., [9], [20]–[22]) to extract relevant information from extensive open student feedback [23]. These methods allow researchers to delve into students' attitudes and emotions [20], [24], as well as assess their perceptions of online instruction [25]. Moreover, sentiment analysis techniques enable the analysis of student feedback while linking learning analytics to grounded theory [25]. Furthermore, employing similar text mining techniques [26] facilitates the automatic identification of the most significant topics in feedback and their associated sentiment. Such methods can also aid in grouping rating results and providing suggestions

[27]. Thus, text mining and its associated methods have many uses in education and can reveal important information about the opinions and reflections of students.

3. METHOD

3.1. Design, participants, and data collection procedures

This study employed a qualitative content analysis design in combination with text mining techniques to analyze reflective documents, to gain a better understanding of the experiences and perceptions of preservice teachers. This research focused on gathering insights from preservice teachers who had completed remote and virtual teaching internships. A total of 142 reflective documents were included in the analysis, collected in January 2022. These reflections served as valuable sources of information to understand the experiences and perceptions of preservice teachers during their internships, particularly in the context of remote and virtual teaching. To obtain the data, formal permission was sought from the college of a state-funded university where the preservice teachers were enrolled. The necessary ethical approvals were obtained, and the college graciously granted access to the reflections for research purposes.

3.2. Data preprocessing

To ensure the reliability and consistency of the data, a series of preprocessing steps were carried out. First, duplicate documents were removed from the dataset to avoid any redundant information. Next, textual contractions were expanded within the documents, for instance, transforming “I’m” to “I am,” to standardize the text format. To further clean the data, all the text was converted to lowercase, so the analysis would not be case-sensitive. Punctuation marks, numbers, including any unreadable texts were removed from the documents to eliminate any potential interference with subsequent analysis. In addition, newlines within the texts were replaced with spaces. This step allowed for effective tokenization, which involved breaking down the text into individual words. To reduce noise in the data and to focus on the most relevant information, stop words were removed. This process involved the elimination of commonly occurring but relatively insignificant words. At the same time, words such as “teach,” “teacher,” “student,” and “internship” were removed as they are considered keywords for the reflections. To further streamline the analysis, plural words were converted to their singular form, which not only minimized redundancy but also ensured consistency in the dataset. Additionally, lemmatization was carried out to reduce each word to its base or root form. This step helped in simplifying the analysis by treating different forms of the same word as one entity. Finally, tokenization was performed to prepare the data for subsequent sentiment analysis and hierarchical clustering. Tokenization involved breaking down the text into individual words, facilitating the examination of sentiments and themes in the reflections.

3.3. Data analysis

Sentiment analysis, a powerful technique in natural language processing, was employed to identify the prevailing sentiments expressed by the preservice teachers in their reflections. This analysis provided valuable insights into the emotional tone and attitudes conveyed through the language used in the documents. To conduct sentiment analysis, the widely used natural language toolkit (NLTK) package library was employed. This allowed for the identification and classification of words and phrases in the reflections as either positive or negative sentiments.

At the same time, to uncover any underlying themes present in the reflections, hierarchical clustering was utilized [28]. Hierarchical clustering is a data analysis technique that groups similar items based on their characteristics, forming clusters that are linked hierarchically [29]–[32]. To determine the optimal number of clusters, the Elbow method in Figure 1 was utilized [31]. The Elbow method was used and determined using statistical indicators and evaluations, and selection was usually based on the point on the plot where the decrease in the plot levels off [33]–[36]. This point represented the optimal number of clusters, which was instrumental in obtaining meaningful and informative clusters for the data (e.g., [37], [38]).

3.4. Visualizations, reporting, and expert consultations

To present the sentiment and clustering results effectively, visualizations were created using the Matplotlib Python package library. Bar charts, dendrograms, and line charts were employed to represent the sentiment frequency and the clusters, including their relationships, visually. These visualizations provided an intuitive and easy-to-understand representation of the clustering outcomes. In reporting the results for the sentiment analysis, only the positive and negative sentiments were presented. This is to allow for a clearer and concise representation of the overall sentiment expressed in the reflections. Afterward, to ensure the accuracy and validity of the clustering results, two experts in the academic field were consulted. Their expertise and insights were invaluable in assigning final labels to the clusters, which enhanced the interpretability and reliability of the findings.

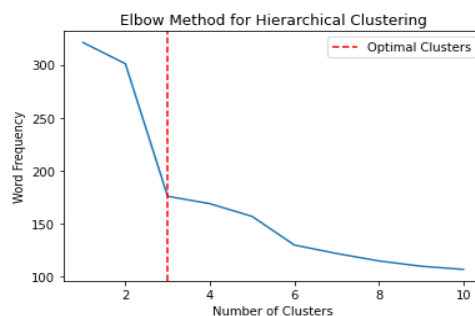


Figure 1. Optimal clusters identified using the Elbow method

4. RESULTS AND DISCUSSION

Table 1 presents the top 10 most frequently used words, along with their respective ranks, within the context of 142 preprocessed documents. The word “learn” stood at the highest rank, making an appearance 321 times, closely followed by “experience” with 301 occurrences. The subsequent frequently used words were “lot,” “also,” and “time.” Additionally, words such as “make,” “class,” “need,” “know,” and “help” were commonly found in descending order. These results suggest that the reflections of preservice teachers revolved heavily around themes of learning, experiences, and various actions involving making, helping, and knowing.

Table 1. Top 10 most frequently used words

Construct	Words	Frequency
1	Learn	321
2	Experience	301
3	Lot	176
4	Also	169
5	Time	157
6	Make	130
7	Class	122
8	Need	115
9	Know	110
10	Help	107

4.1. Sentiments as expressed through reflections

Figure 2 displays the top 30 words categorized based on their sentiment using the NLTK lexicon library. Among these words, six were classified as negative, while nine out of the ten words were identified as positive. The most prevalent negative word was “hard,” whereas the ten most frequently occurring positive words were, in descending order, “well,” “good,” “work,” “great,” “like,” “easy,” “improved,” “best,” and “skill.”

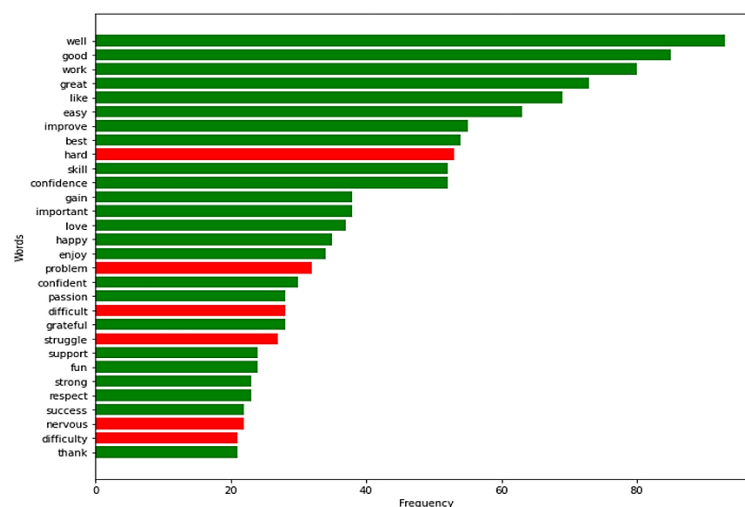


Figure 2. Top 30 positive and negative words based on frequency

4.2. Themes identified through cluster analysis

The study used hierarchical clustering to identify three distinct groups, as shown in Figure 3. Table 2 shows that 13 documents are grouped into cluster 1, 59 into cluster 2, and 70 into cluster 3. From these groups, three key themes emerged from the preservice teachers' reflections: professional growth and development, passion for teaching and connection, and adaptability and resilience. Together, these themes offer a clearer picture of the teachers' reflective discourses in the context of online teaching.

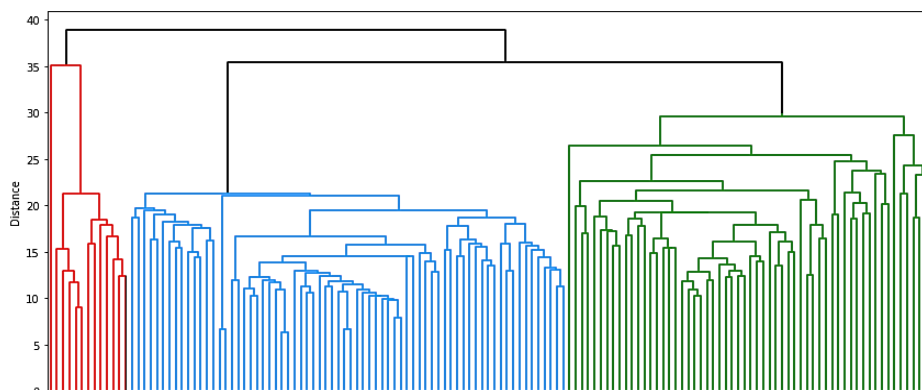


Figure 3. Visualization of clusters using dendrogram

Table 2. Cluster labels

Cluster no.	Labels	Sample document no.	Frequency
1	Professional growth and development	22, 47, 54, 83, 84	13
2	Passion for teaching and connection	3, 4, 7, 11, 19	59
3	Adaptability and resilience	2, 5, 6, 8, 10	70

4.2.1. Professional growth and development

The theme of professional growth and development emerged prominently from the pre-service teachers' reflective discourses on online teaching. Several key concepts highlighted different aspects of their experiences. First, reflection and personal growth emphasized the importance of self-reflection for personal development, illustrating the introspective nature of the teaching profession. For instance, Butakor [39] emphasized that online teaching positively impacted pre-service teachers by boosting confidence and allowing self-scheduled learning, which contributes to their professional growth. However, Butakor [39] also highlighted several challenges that shaped their development, such as high cost and limited interactions with their teachers. Second, learning through teaching highlighted the reciprocal relationship between teaching and learning. This shows how instructing others contributes to the pre-service teachers' intellectual and pedagogical growth. This aspect of knowledge building within their communities of practice is echoed in the study of Yilmaz and Bağçeci [40]. Similarly, Richards [41] identified that self-directed learning and group interactions are key determinants in developing professionals' knowledge among teachers in an online setup. Hadijah and Shalawati [42] also stated that coaching and feedback from teachers help in honing pre-service teachers' skills with online teaching. Third, the subtheme of challenges and growth explored the obstacles faced by pre-service teachers and how overcoming these challenges facilitated their professional development. This indicates the necessity to support pre-service teachers to overcome their challenges in online teaching [43]. Fourth, reflection and self-improvement stressed the ongoing cycle of self-assessment and enhancement critical for effective teaching. For instance, Weber *et al.* [44] believed online self-reflection and feedback are seen as key in improving classroom management skills during teacher practicum experiences. Weber *et al.* [44] further stated that these kinds of interventions can significantly enhance pre-service teachers' professional vision. Finally, professional responsibility focused on the ethical and moral aspects of teaching. This highlights the pre-service teachers' commitment to creating a positive virtual learning environment. These subthemes collectively provided a comprehensive understanding of the complex nature of professional growth and development among pre-service teachers in an online setting.

4.2.2. Passion for teaching and connection

The theme of passion for teaching and connection was also evident in the reflective discourse. The concept of passion for teaching highlighted the intrinsic motivation that drives pre-service teachers to commit

to the teaching profession. Building connections with students emerged as a crucial element, emphasizing the importance of forming meaningful relationships in virtual classrooms. For instance, both Aragundi and Game-Varas [45] and Parija and Bobhate [46] highlighted that building connections and rapport is crucial for student engagement in online learning environments and is an essential aspect to maintain interest and commitment in the academe. The themes of love and compassion demonstrated the empathetic nature of teaching. This highlights the emotional bonds between pre-service teachers and their students. This emotional empathy and compassion play crucial roles in teaching. Studies show that pre-service teachers often exhibit compassionate practices during emotionally intense moments [47]–[49]. Achievement and fulfillment were also important. This recognized the sense of accomplishment derived from seeing students progress and succeed [50]. Lastly, the sense of accomplishment reflected the personal satisfaction pre-service teachers felt after overcoming the challenges of online teaching [51]. These themes illustrated how dedication, emotional connection, and intrinsic rewards enhanced the pre-service teachers' passion for and connection to teaching, even in a virtual environment [51], [52].

4.2.3. Adaptability and resilience

The theme of adaptability and resilience was prominently featured in the discourses. Adapting to challenges highlighted the proactive steps taken by pre-service teachers to overcome obstacles in online teaching [39]. Embracing challenges revealed a mindset that fosters a positive response to difficulties. This demonstrates the potential for growth in each challenge. The concepts of resilience and adaptability describe how the ability to bounce back from setbacks is closely linked to the capacity to adjust to changing circumstances. In a study by Mohafa and George [53], it was highlighted that the connection between resilience and their ability to overcome challenges. In their study, pre-service teachers initially struggled with confidence in their online teaching abilities. However, as they adapted, their perceptions of online teaching efficiency have improved. Finally, adapting to new learning modes examined how pre-service teachers integrated into new educational methods. This showcases their flexibility in accepting new ways of teaching. These elements collectively illustrated the importance of adaptability and resilience in navigating the online teaching landscape [54]–[56].

5. CONCLUSION

The analysis of online teaching internships during COVID-19 reveals that teacher interns see online teaching as an opportunity to apply theoretical knowledge in practice, though they face challenges such as increased workload and the need for extra preparation time. Despite these hurdles, reflective practice played a key role in improving teaching methods. Sentiment analysis shows that interns generally had positive experiences, which demonstrates both resilience and adaptability. The results suggest that integrating reflective practices into teacher education can better prepare preservice teachers for online teaching challenges. Recommendations include curriculum development, targeted support, and professional development to address the complexities of online education.

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Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Julius Ceazar G. Tolentino	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
John Paul P. Miranda	✓	✓	✓		✓	✓	✓	✓		✓	✓			✓

C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

O : **O**riting - **O**riginal Draft

E : **E**riting - **R**eview & **E**editing

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

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CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

The authors obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research complied with the tenets of the Belmont Report, Helsinki Declaration, the Philippine Data Privacy Act of 2012, and the Philippine Council for Health Research and Development's National Ethical Guidelines for Research Involving Human Participants 2022. This research has been approved by the authors' institutional review board.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [JCGT], upon reasonable request.

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BIOGRAPHIES OF AUTHORS



Julius Ceazar G. Tolentino    is an associate professor of health education, physical education, and curriculum studies. He currently serves as the chairperson of undergraduate programs in physical education, culture and arts education, and exercise and sports sciences at the College of Education, Pampanga State University, Pampanga, a CHED-recognized Center of Development for Teacher Education. He also serves as the chairperson for the institution's graduate program in physical education. In the same university, he completed his bachelor's degree in secondary education majoring in music, arts, physical and health education in 2013. He also obtained his degree, master in physical education and sports at the Bataan Peninsula State University, City of Balanga, Bataan in 2016, where he used to work as an adjunct faculty in its graduate school. Moreover, in July 2021, he obtained his degree, master of science in human movement science from the University of the Philippines Diliman as the Outstanding HMS graduate. He is currently writing his dissertation for the degree, PhD in curriculum and instruction at the Philippine Normal University-Manila. He has presented and published research papers in the fields of physical education, educational technology, and cultural studies, indexed in Scopus, Clarivate Analytics, and ASEAN-citation among others. He can be contacted at email: jcgtolentino@pampangastateu.edu.ph.



John Paul P. Miranda    is an associate professor and the international linkages and partnerships project head for the Office for International Partnerships and Programs at Pampanga State University. His publications are indexed in Scopus, Web of Science, and IEEE databases. He is a proud associate member of the National Research Council of the Philippines, an attached agency to the Department of Science and Technology, which is an advisory body to the Philippine Government on matters of national interest. His areas of interest in publications are related to data science, analytics, educational technology, and software development. He can be contacted at email: jppmiranda@pampangastateu.edu.ph.